Remarks

Claims 55-103 are pending. Claims 55, 69, 77, 91, and 97 are independent.

Rejections under 35 U.S.C. §112

Claims 58 and 61 were rejected under 35 U.S.C §112, first paragraph, as lacking enablement. The rejections are respectfully traversed.

The devices of Applicants' claims 58 and 61 are fully enabled by the specification. A description as filed is presumed to be adequate, unless or until sufficient evidence or reasoning to the contrary has been presented by the examiner to rebut the presumption. *See, e.g.*, In re Marzocchi, 439 F.2d 220, 224, 169 U.S.P.Q. 367, 370 (C.C.P.A. 1971); M.P.E.P. § 2163. Here, the Examiner has identified no evidence that the claimed devices lack sufficient disclosure for one skilled in the art to practice the invention. The Examiner has articulated no well reasoned basis to allege that one skilled in the art—who has read Applicants' disclosure and who already possesses information known in the art—would require undue experimentation to make or use Applicants' claimed devices. The skilled artisan can readily ascertain from Applicants' disclosure the information needed to make and use a device that include two reservoir sections forming a single reservoir.

Applicants' specification well describes two reservoir sections forming a single reservoir, such that a person of ordinary skill can readily duplicate it. The Examiner erroneously argues that "Figs. 9c-9d or in the specification on page 33, line 16-page 34, line 3 do not disclose the limitation that 'the two reservoir sections formed a single reservoir" as in claims 58 and 61'" (Office Action, p. 7). On the contrary, Applicants' direct the Examiner's attention to page 3, lines 1-6 of the specification, which recites the language of claims 58 and 61 almost verbatim:

> . . . a reservoir section in the upper substrate portion is in communication with a reservoir section in the lower substrate portion, the *two reservoir sections forming a single reservoir* . . . (emphasis added).

Coupled with other details found throughout Applicants' specification (e.g., P. 10, Ln. 11 to P. 12, Ln. 30; P. 21, Ln. 2 to P. 22, Ln. 14), one skilled in the art would not require undue experimentation to be able to bond top and bottom substrate portions together, or to fill the reservoirs (e.g., 720a/720b) with molecules for release, or to cover the reservoirs with reservoir caps, or to seal the reservoirs with a backing plate. No sound technical reason or evidence has been presented by the Examiner to doubt that one of ordinary skill in the art—who is not an automaton, but instead who possesses ordinary creativity and common sense (*see* Teleflex, Inc. v. KSR Int'l Co., 550 U.S. __, 127 S. Ct. 1727, 1742 (2007))—can make and used two reservoir sections forming a single reservoir without undue experimentation. The Examiner has failed to establish a *prima facie* case of a lack of enablement. Accordingly, the rejection should be withdrawn.

Rejections under 35 U.S.C. §102

Claims 77-103 are rejected under 35 U.S.C. §102(b) as anticipated by U.S. Patent No. 5,366,454 to Currie et al. (hereinafter "Currie"). The rejections are respectfully traversed.

Currie Does Not Disclose Disintegration of a Reservoir Cap.

The Examiner erroneously contends that Currie's disclosure of using the reverse piezo effect to rupture a rupturable membrane is identical to Applicants' disintegration of reservoir caps, citing definitions for "disintegration" and "rupture" from www.answers.com without any explanation of how these definitions are alleged to be substitutable for what one of skill in the art

would understand the terms to mean, rather than what the terms mean when read in view of, in the context of, Applicant's and Currie's own specifications. "The Patent and Trademark Office ('PTO') determines the scope of claims in patent applications not solely on the basis of the claim language, but upon giving claims their broadest reasonable construction '**in light of the specification as it would be interpreted by one of ordinary skill in the art.**' *In re Am. Acad. of Sci. Tech. Ctr.*, 367 F.3d 1359, 1364, 70 U.S.P.Q.2d 1827 (Fed. Cir. 2004). M.P.E.P. § 2111.

In view of Applicants' specification, the skilled artisan would conclude that Applicants' reservoir cap disintegration is not taught by Currie, because "disintegration" is not the same as "rupture." Currie teaches a piezoelectric thin film 34 that lays on top of a rupturable silicon membrane 24 so that the membrane is always in a stressed condition, and when voltage is applied, the additional stress from the piezo stack ruptures the membrane 24 (See Col. 2, Lns. 25-31; Col. 5, Ln. 59 to Col. 6, Ln. 28). Currie also teaches that a bio-compatible film 50 encapsulates the device (Fig. 4; Col. 6, Ln. 66 to Col. 7, Ln. 3) to catch fragments of the fractured membrane from being ejected into the patient. Thus, this rupture of Currie is a mechanical, macroscale fragmentation due to displacement forces, which is distinct from Applicants' disintegration of reservoir caps, which involves a molecular scale transformation, such as a phase change or chemical reaction, in the reservoir cap structure, which change is not mechanically driven fragmentation.

Moreover, the Examiner's "evidence" does not support that Currie's rupture mechanism anticipates Applicants' disintegration of a reservoir cap. One skilled in the art would appreciate that "disintegration" as defined by the Examiner has nothing to do with Currie, because "decay," "breakdown," and "decomposition" which result from a chemical or phase change involving

molecular rearrangement are neither identical nor equivalent to the macroscale mechanical breaking open or bursting operations understood by the term "rupture" as defined by the Examiner.

Currie Does Not Disclose a Reservoir Cap Comprising a Metal Film.

Claims 85 and 94, which each specify that the reservoir caps comprise a metal film, are not anticipated by Currie. The Examiner has conceded as much. "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, is a single prior art reference." Verdegaal Bros. v. Union Oil Co. of California, 814 F.2d 628, 631 (Fed. Cir. 1987). A claim element is not "inherent" in the disclosure of a prior art reference unless extrinsic evidence clearly shows that missing descriptive matter is **necessarily** present in the thing described in the reference. In re Robertson, 49 U.S.P.Q. 1949 (Fed. Cir. 1999). "Inherency, however, may not be established by mere probabilities or possibilities." Id. at 1950-51. Currie fails to disclose that Currie's rupturable membrane necessarily is a metal film. The Examiner has provided no evidence or sound technical reasoning to support even an inference that Currie's device necessarily includes a metal film closing off the opening to one of the compartments. The rejection therefore necessarily fails.

Rejections under 35 U.S.C. § 103

Claims 55-76, 85, and 94 are rejected under 35 U.S.C. §103(a) over Currie. The rejections are respectfully traversed.

No *prima facie* case of obviousness has been made for claims 55 and 69. The Examiner's rationale for the rejection is factually and legally improper. Nothing in Currie

suggests a device that includes metal reservoir caps or electrically conductive reservoir caps, as required by Applicants' independent claims 55 and 69, respectively. The Examiner misinterprets the prior art, improperly uses Applicants' own specification as prior art, and ignores countervailing facts that would lead one of ordinary skill away from doing that which the Examiner alleges to be obvious to do.

First, Currie does not disclose that the silicon membrane "can be used as an anode material." One of skill in the art would not confuse an anodic material during a fabrication process with an anode and cathode in one of Applicants' reservoir cap disintegration processes. None of the prior art shows that the silicon membrane disclosed in Currie can be used as an anode material. Currie's disclosure does not, under any interpretation by one of ordinary skill in art, mean that the silicon membrane can be used as an anode material. Anodic bonding of silicon to silicon wafer utilizes Pyrex glass as an intermediary and requires a negative cathode coupled to the Pyrex glass and a positive anode coupled to the silicon wafer. A large voltage is then applied between the electrodes to create migration of Na+ ions in the glass towards the cathode, leaving a negative charge at the interface which, as the electrons from the Si are drawn to the anode, attracts the Si+ ions from the silicon wafer to form a strong SiO_2 interface to bond the silicon wafer to the glass. This allows the formation of SiO_2 at a thin interface layer to bond one silicon wafer to another silicon wafer by bonding each silicon wafer to opposite sides of the Pyrex interlayer. (See e.g., Fundamentals of Microfabrication: The Science of Miniaturization, Madou, M., 2d ed. At pp. 484-485 (CRC Press 2002)) (Attached hereto as **Appendix A**). Thus, silicon is not used as an anode during anodic bonding.

Second, Applicants' specification is not prior art, and none of Auborn, Sapru, or Miyazaki provide evidence that the silicon membrane disclosed in Currie can be used as an anode material. Auborn and Sapru are misinterpreted by the Examiner. Auborn discloses as an anode a <u>metal and silicon alloy</u>. Sapru discloses an anode comprising a disordered <u>multicomponent</u> material formed of a host matrix element, which may be silicon, and modifier elements. Thus, both Auborn and Sapru disclose anodes requiring silicon *and another material*, whereas Currie discloses a membrane comprising *only* silicon.

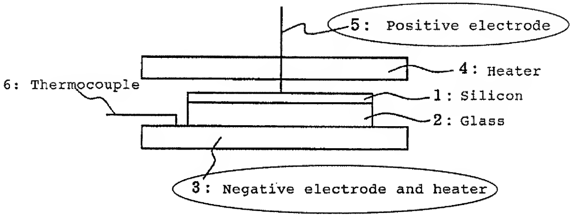
Furthermore, the single line of Miyazaki cited by the Examiner is contrary to the remainder of the Miyazaki specification and the knowledge in the art. Miyazaki discloses:

> using the silicon as an anode and the glass as a cathode, a DC voltage is applied to heat-bond them. It is considered that the **cations in the glass move to <u>the cathode</u>**. . . (Col. 1, lines 31-34) (emphasis added).

In the same portion of the Miyazaki disclosure relied upon by the Examiner, Miyazaki contradicts himself by first stating that the glass is used as a cathode and then stating that *cations in the glass move to a cathode*. The silicon and glass are not used as electrodes, but rather a separate anode and cathode are actually required for anodic bonding to occur as disclosed in the remainder of Miyazaki. For instance, the examples in Miyazaki describe and illustrate *separate electrodes* to anodically bond silicon and glass.

> . . . anodic bonding was carried out in such a manner that in an apparatus provided with heaters **3** and **4** made of carbon and **<u>electrodes 3 and 5</u>**, as shown in FIG. 1, the silicon (a silicon wafer) **1** and a glass plate **2** were disposed . . . (Col. 4, line 65 to Col. 5, line 2) (emphasis added).

FIG. 1



Thus, the only way of reading of Miyazaki as a whole is that the single line cited by the Examiner must be erroneous. One of ordinary skill would not, in view of Miyazaki as a whole and the principles known in the art (See e.g., Fundamentals of Microfabrication: The Science of Miniaturization discussed above) interpret Miyazaki as the Examiner has done.

Auborn is directed to an electrochemical cell having a simplified design; Sapru is directed to a long cycle life rechargeable battery; and Miyazaki is directed to glass for efficient anodic bonding. None of these disclose or suggest a reason to modify the peizoelectric mechanism of Currie's rupture release system, and Currie's silicon membrane is not an anode material. Accordingly, there would be no apparent reason for a skilled artisan to modify the rupture release system disclosed in Currie with the anode components of the prior art, or to even look to the prior art documents identified by the Examiner.

Conclusions

The claims are definite and patentable over the prior art of record. Prompt allowance of each of pending claims is therefore respectfully solicited.

The undersigned kindly invites the Examiner to contact him by telephone (404.853.8068) if any outstanding issues can be resolved by conference or examiner's amendment.

Respectfully submitted,

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Date: May 15, 2008

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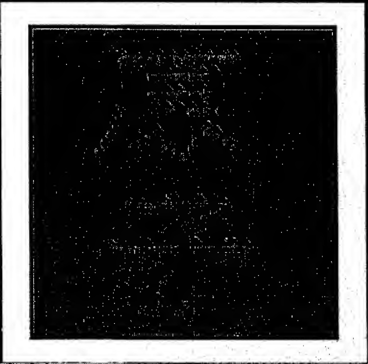
APPENDIX A

Marc J. Madou



Fundamentals of MICROFABRICATION

The Science of Miniaturization

Second Edition

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Marc J. Madou

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On the cover: Kanji character for "atom," by Lutz and Eigler, IBM, Almaden. An example of manipulation/mechanosynthesis of iron atoms on a Cu surface with an STM. (Courtesy of D. Eigler.)

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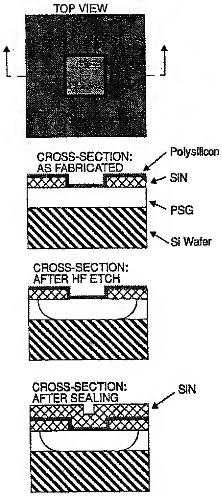

Figure 8.11 Schematic of etch access window design, operation, and sealing. (After Lebouitz et al., 8th Int. Conf. on Solid-State Sensors and Actuators, Transducers '95, Stockholm, Sweden, 224–27, 1995.[46])

arrays of 30 caps. The HEXSIL mold wafer is reusable. An example of a transferred encapsulation cap is shown in the SEM micrograph in Figure 8.13C.

Many of the newfound ways of hermetically sealing and bonding different layers and making contacts between them increasingly interest IC manufacturers. An important opportunity for micromachinists is to transfer the developed 3D machining technologies to the newest generations of 3D ICs.

Bonding

Field-Assisted Thermal Bonding

Field-assisted thermal bonding, also known as *anodic* bonding, *electrostatic* bonding, or the *Mallory process*, is commonly used for joining glass to silicon. The main utility of the process stems from the relatively low process temperature. Since the glass and Si remain rigid during anodic bonding, it is possible to attach glass to Si surfaces, preserving etched features in either the glass or the silicon. This method is mostly applicable to wafer-scale die bonding (L1).

A bond can be established between a sodium-rich glass, say Corning #7740 (Pyrex), and virtually any metal.[59] Besides Pyrex, Corning #7070, soda lime #0080, potash soda lead #0120, and aluminosilicate #1720 are suitable as well.[60] In the case of Si, Pyrex is most commonly used. Bonding can be accomplished on a hot plate in atmosphere or vacuum at temperatures between 180 and 500°C. Typical voltages, depending on the thickness of the glass and the temperature, range from 200 to 1000 V. The operating temperatures are near the glass-softening point but well below its melting point, as well as below the sintering temperature of standard AlSi metallization. At the most elevated temperatures, the wafers are bonded in 5 to 10 min, depending on voltage and bonded area.[60] Compared with Si fusion bonding (see below), anodic bonding has the advantage of being a lower-temperature process with a lower residual stress and less stringent requirements for the surface quality of the wafers. Figure 8.14 represents a schematic of an anodic bonding setup. Generally, one places a glass plate on top of the Si wafer and makes a pinpoint contact to the uppermost surface of the glass piece, which is held at a constant negative bias with respect to the electrically grounded silicon. The bonding is easy to follow. Looking through the glass, the bonded region moves from the contact cathode pinpoint outward and can be detected visually through the glass by the disappearance of the interference fringes. When the whole area displays a dark gray color, the bonding is complete. A constant current, instead of constant voltage, could also be used but is avoided, since dielectric breakdown may occur after the bonding is complete and the interface becomes an insulator (see bonding mechanism below). The contacting surfaces need to be flat (surface roughness $R_a < 1$ µm) and dust free for a good bond to form. The native or thermal oxide layer on the Si must be thinner than 200 nm. The thermal expansion coefficients of the bonded materials must match in the range of bonding. In Figure 8.15, we show the thermal expansion coefficient of Si and Pyrex as function of temperature (see also Figure 4.27).[61]

Above 450°C, the thermal properties of the materials begin to deviate seriously; therefore, the process should be limited to 450°C. One also would expect that Si would be under compression for seal temperatures below 280°C and under tension for temperatures in excess of 280°C.[61] Wafer curvature measurements indicate, however, that the transition from concave 7440 glass/Si sandwiches (Si under compression) to convex sandwiches (Si under tension) lies around a seal temperature of 315°C.[61,62] This indicates that other non-negligible, stress-inducing effects add an additional compressive component. As we learned before, for most applications tensile stress is preferred over compressive stress, and a considerable safety margin toward higher bonding temperatures must be respected to avoid buckled Si membranes and bridges.

The anodic bonding mechanism is not yet completely understood. Electrochemical, electrostatic, and thermal mechanisms and combinations thereof have been suggested to explain bond formation, but the dominant mechanism has not been clearly defined. It is suggested that, at elevated temperatures, the glass becomes a conductive solid electrolyte, and the bonding results through the migration of sodium (Pyrex contains approximately

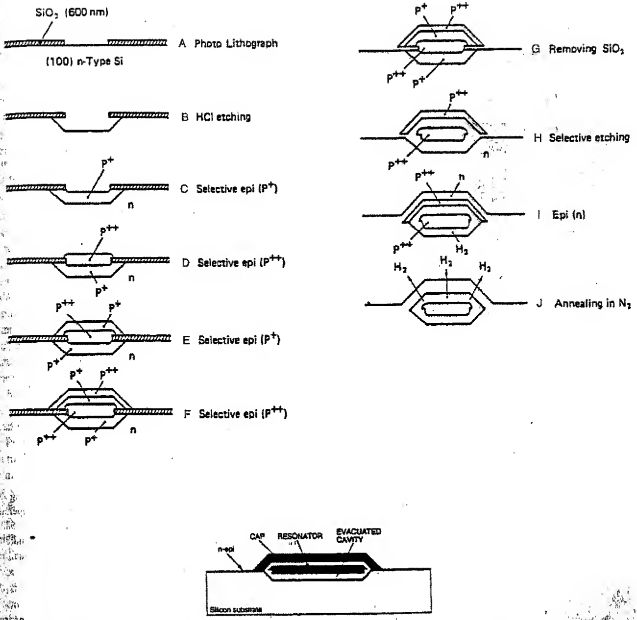

Figure 8.12 Epilayer-based fabrication process of a vacuum-encapsulated resonant beam. Process from (B) to (F) is carried out in one batch epitaxial process. (After Ikeda et al., *Sensors and Actuators A*, A21, 146–50, 1990.[56])

to 5% sodium) toward the cathode. As it moves, it leaves a space charge (bound negative charges) in the region of the glass/silicon interface. Most of the applied voltage drop occurs across this space charge region, and the high electrical field between the glass and Si results in an electrostatic force that pulls the glass and Si into intimate contact. The elevated temperatures result in covalent bonds forming between the surface atoms of the glass and the silicon. A good quantitative discussion on the many important effects in anodic bonding is by Anthony.[63]

Field-assisted bonding has also been applied to bond GaAs to glass. Corning #0211 is used at 360°C, and a bias of 800 V is applied for 30 min to complete the bonding process. It is well known that GaAs forms very poorly adhering oxides, leading to poor anodic bonding; prebake of the glass at 400°C for 15 hr in a reducing atmosphere (H_2 and N_2) is reported to lead to better bonding.[58] Von Arx et al. bonded glass capsules to a smooth poly-Si surface to form a hermetically sealed cavity large enough to contain hybrid circuitry of a biocompatible implant.[64]

The high electrical field and the migration of sodium make anodic bonding of glass plates to Si a rather difficult technology. The mismatch in thermal expansion coefficient between the glass and the Si causes both thermally induced and built-in mechanical stress. In addition, the viscous behavior of the glass results in degraded long-term stability of the components. As a result of these problems, several modifications of the basic technology have been introduced (see below). A typical commercial instrument for anodic bonding is from Electronic Visions Co.'s 500 Series-Wafer Bonding Systems (e.g., the EV560).

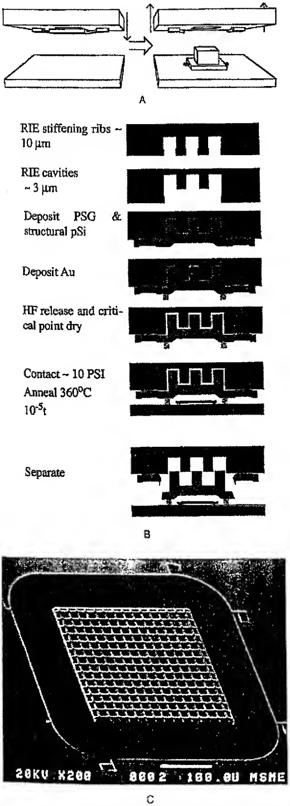

Figure 8.13 Wafer-to-wafer transfer of encapsulation structures. (From Hok et al., *Appl. Phys. Lett.*, 43, 267–69, 1983.[58] Reprinted with permission.) (A) Principle of the wafer-to-wafer transfer method of encapsulation caps. (B) Fabrication of the tethered caps in a HEXSIL process. (C) SEM micrograph of a transferred cap.[57] (Courtesy of Dr. M. Cohen, University of California, Berkeley.)

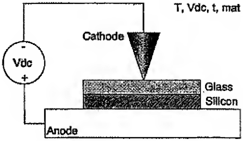

Figure 8.14 Principle sketch of anodic glass-to-Si bonding. Control parameters are temperature (300 to 400°C), bias voltage (700 to 1200 V), time (~2 min), and materials (glasses, Si, SiO_2).

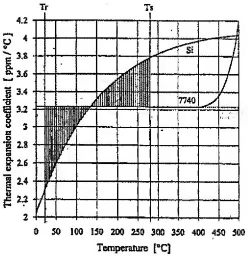

Figure 8.15 Thermal expansion coefficients of Si and Corning 7740 Pyrex. Tr = room temperature; Ts = seal temperature. The temperature Ts is a variable. (After E. Peeters, "Process Development for 3D Silicon Microstructures with Application to Mechanical Sensor Design," Ph.D. thesis, Catholic University of Louvain, Belgium, 1994.[61])

Field-Assisted Thermal Bonding Modifications

The pinpoint method for anodic bonding, as illustrated in Figure 8.14, requires a very high bias voltage and a long period of time to bond areas far removed from the cathode point, since the electrical field in the glass substrate diminishes fast as the distance from the pinpoint cathode increases. At NEC, a Ti mesh bias electrode is deposited over the whole glass wafer to accomplish faster bonding. Because of the mesh assistance, the whole wafer may be Si bonded at 400°C and 600 V in less than 5 min, compared with over an hour at the same temperature and voltage without the mesh.[65]

Another modification of anodic bonding by Sander[66] involves deposition of intermediate layers of Si dioxide and aluminum to screen the underlying Si from harm from the high electrical fields. First, Si dioxide is thermally grown on the Si surface. Then, a layer of aluminum is deposited on the oxide surface. Finally, a piece of glass is bonded to the aluminum. This technique produces a good hermetic seal, but the soft aluminum